Effectiveness of Photodynamic Therapy and Probiotics as an Adjunct to Scaling and Root Debridement in the Treatment of Chronic Periodontitis

Lo S Ann, Gun C Yin, Siti Fatimah, Ng S En, Daniel D Dicksit, C. G Kalyan, Khairiyah A Muttalib, Srinivas S Ramachandra,
Faculty of Dentistry, SEGi University, Selangor, Malaysia

Abstract
Objective: This study aimed to evaluate the effectiveness of a single application of photodynamic therapy (PDT) and probiotics as an adjunct to scaling and root debridement (SRD) to treat chronic periodontitis. The objectives of the study were to compare the probing pocket depths and clinical attachment loss (CAL) in experimental sites (E-sites) treated with PDT and probiotics with SRD against SRD alone (controls) at the baseline and 3 months post intervention. Materials and Methods: In 22 chronic periodontitis patients aged 25–45 years, 136 sites with pocket depths of 4–6 mm were identified. In each patient, one E-site was randomly selected while one served as control. E-sites were treated with SRD + PDT + probiotics whereas control sites received only SRD. Clinical parameters of pocket depths and CAL were measured at the baseline and at 3 months. Results: In the E-sites, mean pocket depth was 3.62 ± 1.40 mm at the baseline and 3.12 ± 1.48 mm after 3 months. In the control sites, the mean pocket depth was 3.43 ± 1.46 mm at the baseline and 2.99 ± 1.45 after 3 months. In the E-sites, the mean CAL before treatment was 5.31 ± 1.39 mm and 5.10 ± 1.46 mm after treatment. In the control sites, mean CAL before treatment was 5.15 ± 1.41 mm and 4.87 ± 1.55 mm after treatment. There was no significant improvement in pockets depths and CAL between the E-sites and control sites. Conclusion: A single application of PDT + probiotics with SRD did not show any additional clinical benefits when compared with SRD alone. Further studies with multiple applications of PDT and probiotics are needed.

Key words: Periodontal disease, photodynamic therapy, probiotics, root debridement

INTRODUCTION
Periodontal diseases are highly prevalent chronic inflammatory conditions that affect the supporting tissues of the teeth, and are characterized by pocket formation and/or gingival recession, leading to progressive attachment loss and bone loss.[1] Various procedures exist for the treatment of chronic periodontitis, ranging from scaling and root debridement to regenerative periodontal surgeries.[2] However, scaling and root debridement remain the mainstay for treatment of chronic periodontitis.[2]

Several adjunctive treatments have been added to the traditional methods of scaling and root debridement (SRD)
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for better clinical results. Among the adjunctive treatments are photodynamic therapy (PDT)\textsuperscript{[3-5]} and probiotics.\textsuperscript{[6,7]}

PDT is a minimally-invasive therapy that kills bacteria and also detoxifies the bacterial endotoxins such as the endotoxins produced by various periodontopathic bacteria.\textsuperscript{[9]} Lipopolysaccharides treated by PDT do not stimulate the production of proinflammatory cytokines, thus resulting in reduced gingival inflammation. PDT uses various photosensitizer molecules which are inserted into the diseased periodontal pocket and are activated using light of a particular wavelength. The activated photosensitizer results in the formation of reactive oxygen species which kill the microbes.\textsuperscript{[10]}

Bacteria causing periodontal disease are seen in the periodontal pockets, as well as in other intraoral sites such as the dorsum of the tongue and tonsillar crypts. Bacteria present in these sites can repopulate the treated periodontal pockets and result in recurrence of the disease.\textsuperscript{[3,4]} Probiotics are healthy bacteria whose insertion into the treated periodontal pockets can prevent or delay the colonization of treated periodontal pockets by periodontopathic bacteria.\textsuperscript{[4]}

The aim of this study was to evaluate the effectiveness of a single application of PDT and probiotics as an adjunct to SRD in the treatment of chronic periodontitis. The objectives were to compare the probing pocket depth and clinical attachment loss (CAL) in sites treated with PDT and probiotics as an adjunct to SRD, versus scaling and root debridement alone at the baseline and at 3 months after periodontal therapy.

MATERIALS AND METHODS

This study was approved by the institutional ethics committee, SEGi University. The study objectives were explained to all the patients involved and informed consents were obtained. Chronic periodontitis patients in the age group of 25–45 years with at least two sites with probing pocket depth of 4–6 mm were included in the study. Patients with systemic disease, smokers, under antibiotic medications since the past 6 months, with aggressive periodontitis, or with toluidine blue allergy were excluded from the study. The study was carried out at the Faculty of Dentistry, SEGi University, Selangor, Malaysia.

Basic periodontal examination (BPE) was followed by detailed periodontal charting to identify sites for the study. After identification of the sites in each patient, half of the sites (50%) were randomly selected as experimental sites (E-sites) and the other 50% served as control sites. The flow of participants has been shown in Figure 1. In 22 chronic periodontitis patients who met the inclusion criteria, 136 sites with pocket depths of 4–6 mm were identified. Sixty-eight (68) sites were randomly selected as E-sites (50%).

At the baseline, parameters examined in E-sites and control sites were bleeding on probing, periodontal probing depths, and CAL. These measurements were repeated at 3 months post intervention. The evaluator (SSR) who measured the sites was blinded regarding the E-sites and control sites.

Figure 1: The participant flow which was followed in the study has been shown.

Figure 2: Image showing the photosensitizer molecule (toluidine blue), Fotosan 630 red light emitting device. Inset shows image of ProlacSan powder containing Lactobacillus brevis/Lactobacillus plantarum. This powder is mixed with saline to produce the probiotic gel.
The materials used in the study included toluidine blue (photosensitizer molecule) and a red light emitting device (630 nm) [Figure 2]. The probiotics contained *Lactobacillus brevis*/*Lactobacillus plantarum* in powder form that was mixed with normal saline to prepare a gel that was then inserted into the E-sites [Figure 2, inset]. Thus, PDT and probiotics was the intervention in the study.

At the E-sites [Figure 3], SRD was done, followed by a single application of the photosensitizer molecule toluidine blue insertion into the periodontal pocket [Figure 4]. Light in the red wavelength spectrum (630 nm) was used to activate the toluidine blue for 10 s [Figure 4, inset, upper corner]. The E-sites were then flushed with normal saline. Probiotic gel was inserted into the periodontal pocket [Figure 4, inset, lower corner]. The remaining 68 control sites were given SRD only. After 3 months post-intervention, patients were reviewed and the parameters of bleeding on probing, periodontal probing depths, CAL were again measured at both E-sites and control sites.

Data was analyzed using MedCalc version 12 easy-to-use statistical software, Acacialaan 22, 8400 Ostend, Belgium. Mean pocket depths and mean CAL with standard deviations (SD) were calculated at both baseline and at 3 months post-intervention for E-sites and control sites. An independent t-test was used to analyze and compare the changes in pocket depths and CAL between E-sites and control sites. Significance level was set at $P < 0.05$.

**RESULTS**

The aim of this study was to evaluate the effectiveness of a single application of PDT and probiotics as an adjunct to SRD in the treatment of chronic periodontitis. Patients suffering from chronic periodontitis in the age group of 25–45 years with at least two sites with pocket depth of 4–6 mm were included. Selected sites were randomly allocated as E-sites and control sites. Control sites were treated with SRD only, whereas E sites were treated with SRD plus single application of PDT and probiotics. Clinical parameters of probing pocket depth and CAL was measured at the baseline and after 3 months of therapy. The mean age of the 22 patients included in the study was $34 \pm 5.5$ years. A total of 136 sites in 22 patients were included in the study, of which 68 were E-sites and 68 served as the control sites. In the E-sites, the mean pocket depth before treatment was $3.62 \pm 1.40$ mm. The mean pocket depth 3 months after treatment in the E-sites (PDT and probiotics) was $3.12 \pm 1.48$ mm. In the control sites, the mean pocket depth before treatment was $3.43 \pm 1.46$ mm. The mean pocket depth after treatment with SRD at the control site was $2.99 \pm 1.45$ mm. There were significant decreases in pocket depths after treatment in both the experimental and control groups ($P = 0.77$) [Table 1].

In the E-sites, the mean CAL before treatment with PDT and probiotics was $5.31 \pm 1.39$ mm. The mean CAL 3 months after treatment was $5.10 \pm 1.46$ mm. In the control sites, the mean CAL before treatment was $5.12 \pm 1.48$ mm. The mean CAL after treatment with only SRD was $4.87 \pm 1.55$ mm. There was no significant gain in CAL after treatment in both the experimental and control groups. When the experimental and control sites were compared,
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Journal of Pharmaceutical Negative Results | January-December 2017 | Vol 8 | Issue 1

SRD did not result in statistically significant difference in pocket depths between the two groups.

Alwaeli et al. (2015) studied 136 sites in 16 periodontitis patients, wherein two randomly assigned quadrants were treated with scaling and root planing and the other two were treated with scaling and root planing plus PDT. The study revealed significant reduction in pocket depths, bleeding on probing, and clinical attachment level after 3, 6, and 12 months. This study concluded that PDT was a valuable adjunct to scaling and root planing.

However, our study also included the additional application of probiotics. In our study, there was no additional benefit of using a single application of PDT and probiotics in addition to scaling and root planing in the E-sites compared with the control sites 3 months postintervention. Other studies also showed no significant improvements in clinical parameters and/or microbiological profiles with single applications of PDT with or without probiotics. Polansky et al. (2009) treated >5 mm deep periodontal pockets in 58 patients with either scaling and root planing alone (control group) or scaling and root planing with application of single cycle of PDT (experimental group). Researchers also screened for the presence or absence of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola before and after therapy in this study. Three months

Table 1: Mean periodontal pocket depth before and after treatment between experimental and control groups

<table>
<thead>
<tr>
<th>Mean periodontal pocket depth</th>
<th>Experimental group (Scaling and root debridement +PDT+ Probiotics)</th>
<th>Control group (Scaling and root debridement only)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean pocket depth before treatment in mm</td>
<td>3.62 ± 1.40</td>
<td>3.43 ± 1.46</td>
<td>0.3238</td>
</tr>
<tr>
<td>Mean pocket depth after treatment in mm</td>
<td>3.12 ± 1.48</td>
<td>2.99 ± 1.45</td>
<td>0.4357</td>
</tr>
<tr>
<td>Mean difference</td>
<td>−0.5000</td>
<td>−0.4412</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>0.0156</td>
<td>0.0384</td>
<td></td>
</tr>
<tr>
<td>Mean difference of pocket depth between experimental and control groups</td>
<td>−0.05882</td>
<td></td>
<td>0.7729</td>
</tr>
</tbody>
</table>

Table 2: Mean clinical attachment loss before and after treatment in experimental and control groups

<table>
<thead>
<tr>
<th>Clinical attachment loss (CAL)</th>
<th>Experimental group (Scaling and root debridement +PDT+ Probiotics)</th>
<th>Control group (Scaling and root debridement only)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL before treatment in mm</td>
<td>5.31 ± 1.39</td>
<td>5.15 ± 1.41</td>
<td>0.3249</td>
</tr>
<tr>
<td>CAL after treatment in mm</td>
<td>5.10 ± 1.46</td>
<td>4.87 ± 1.55</td>
<td>0.1875</td>
</tr>
<tr>
<td>Mean difference</td>
<td>−0.2059</td>
<td>−0.2794</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>0.3081</td>
<td>0.1427</td>
<td></td>
</tr>
<tr>
<td>Mean difference of pocket depth between experimental and control groups</td>
<td>0.07353</td>
<td></td>
<td>0.7018</td>
</tr>
</tbody>
</table>

there was no significant difference in the improvement of CAL between the experimental and control groups (P = 0.70) [Table 2].

DISCUSSION

The aim of this study was evaluate the clinical benefits of single application of photodynamic therapy and probiotics as adjunct to SRD in the treatment of chronic periodontitis. PDT is based on the concept that certain photosensitizers can be applied to infected tissues, and subsequently, these photosensitizers can be activated with the appropriate wavelength (energy) of light to generate active molecular species, such as free radicals and singlet oxygen, that are toxic to periodontopathic bacteria.[8] Probiotics are healthy bacteria which populate the oral cavity and in turn delay or prevent the colonization of gingival sulcus/periodontal pocket from disease causing bacteria.[9] Clinical parameters such as probing pocket depth and CAL was measured at the baseline and 3 months posttreatment.

In this study, 68 sites were randomly assigned as experimental sites (SRD + PDT + probiotics) and 68 sites served as control sites (SRD only). The results of the study showed that there was a significant decrease in pocket depths in both E-sites and control sites. However, the addition of PDT and probiotics to the E-sites after SRD did not result in statistically significant difference in pocket depths between the two groups.

Alwaeli et al. (2015) studied 136 sites in 16 periodontitis patients, wherein two randomly assigned quadrants were treated with scaling and root planing and the other two were treated with scaling and root planing plus PDT. The study revealed significant reduction in pocket depths, bleeding on probing, and clinical attachment level after 3, 6, and 12 months. This study concluded that PDT was a valuable adjunct to scaling and root planing. However, our study also included the additional application of probiotics. In our study, there was no additional benefit of using a single application of PDT and probiotics in addition to scaling and root planing in the E-sites compared with the control sites 3 months postintervention.

Other studies also showed no significant improvements in clinical parameters and/or microbiological profiles with single applications of PDT with or without probiotics. Polansky et al. (2009) treated >5 mm deep periodontal pockets in 58 patients with either scaling and root planing alone (control group) or scaling and root planing with application of single cycle of PDT (experimental group). Researchers also screened for the presence or absence of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola before and after therapy in this study. Three months
after the therapy, there were significant improvements in pocket depths, clinical attachment levels, and bleeding on probing in both groups. However, there was no additional benefit with the addition of PDT.\textsuperscript{[11]} Although \textit{P. gingivalis} was significantly reduced in both groups, there were no significant reductions of \textit{T. forsythia} and \textit{T. denticola}.\textsuperscript{[11]} Carvalho \textit{et al.} randomly treated 34 chronic periodontitis patients using scaling root planing plus PDT as test group, whereas scaling and root planing served as controls.\textsuperscript{[13]} The results of the study showed no significant improvement in the clinical parameters or in the microbiological profile of the patients.\textsuperscript{[12]} Hence, the results of our study concur with the studies by Polansky \textit{et al.} (2009),\textsuperscript{[13]} and Carvalho \textit{et al.} (2015)\textsuperscript{[13]} in not showing any significant improvements in clinical parameters post intervention.

Chondros \textit{et al.} (2009) randomly treated 24 chronic periodontitis patients with either subgingival scaling and root planing followed by a single episode of PDT (test) or subgingival scaling and root planing alone (control).\textsuperscript{[13]} Microbiological evaluation was also done using polymerase chain reaction test. The study similarly concluded that application of a single episode of PDT to scaling and root planing failed to result in an additional improvement in terms of reduction of pocket depths and gain in clinical attachment levels.\textsuperscript{[13]} Again, the results of our study concur with that of Chondros \textit{et al.} (2009).

Penala \textit{et al.} (2016) studied the adjunctive use of subgingival delivery of probiotics and probiotics mouthwash along with scaling and root debridement in 32 systemically healthy patients.\textsuperscript{[14]} Microbial assessment was done among patients at the baseline and at 1 and 3 months. All the clinical and microbiological parameters were significantly reduced in both groups at the end of the study.\textsuperscript{[14]} However, only pocket depth reduction in moderate pockets in the test group (SRD + probiotics) showed significant reduction over the control group.

Sreedhar \textit{et al.} studied 60 sites in 15 chronic periodontitis patients.\textsuperscript{[15]} The sites were randomly treated with one of the four treatment modalities: (1) Scaling and root planing (SRP) alone; (2) SRP + curcumin application for 5 min; (3) SRP + curcumin application for 5 min + irradiation with blue light emitting diode of wavelength 470 nm for 5 min. (Curcumin PDT) on 0 day; (4) SRP + Curcumin PDT on 0, 7th, and 21st day. Probing pocket depth, clinical attachment level, and sulcus bleeding index were measured at the baseline and three months after treatment.\textsuperscript{[15]} The study concluded that curcumin PDT as an adjunct to scaling and root planing has additional clinical and microbiological benefits over scaling and root planing alone. Multiple applications of PDT were found to be more beneficial than single application in reducing clinical and microbiological parameters.\textsuperscript{[15]} Findings of the study by Sreedhar \textit{et al.} are in contrast to the findings of our study. In our study, application of PDT was carried out only once, whereas Sreedhar \textit{et al.} repeated the application on 0, 7th, and 21st day with positive results.

\textbf{Limitations of the study}

Our study did not assess the microbiology of the periodontal pockets before or after therapy. Because PDT involves the application of the photosensitizer molecule into the deepened gingival sulcus, this therapy would have no practical use in sites with CAL but with normal gingival sulcus. Application of probiotic gel is also not possible in such sites.

\textbf{CONCLUSION}

In patients with chronic periodontitis, the addition of a single application of PDT + probiotics with SRD did not show any additional clinical benefits when compared with SRD alone. Further studies with multiple applications of PDT and probiotics with longer follow-up durations are needed.

\textbf{Acknowledgement}

The authors acknowledge the support of Bintang Saudara Dental Supplies Sdn Bhd, Malaysia who supported with products for our study.

\textbf{Financial support and sponsorship}

Nil

\textbf{Conflicts of Interest}

There are no conflicts of interest

\textbf{REFERENCES}